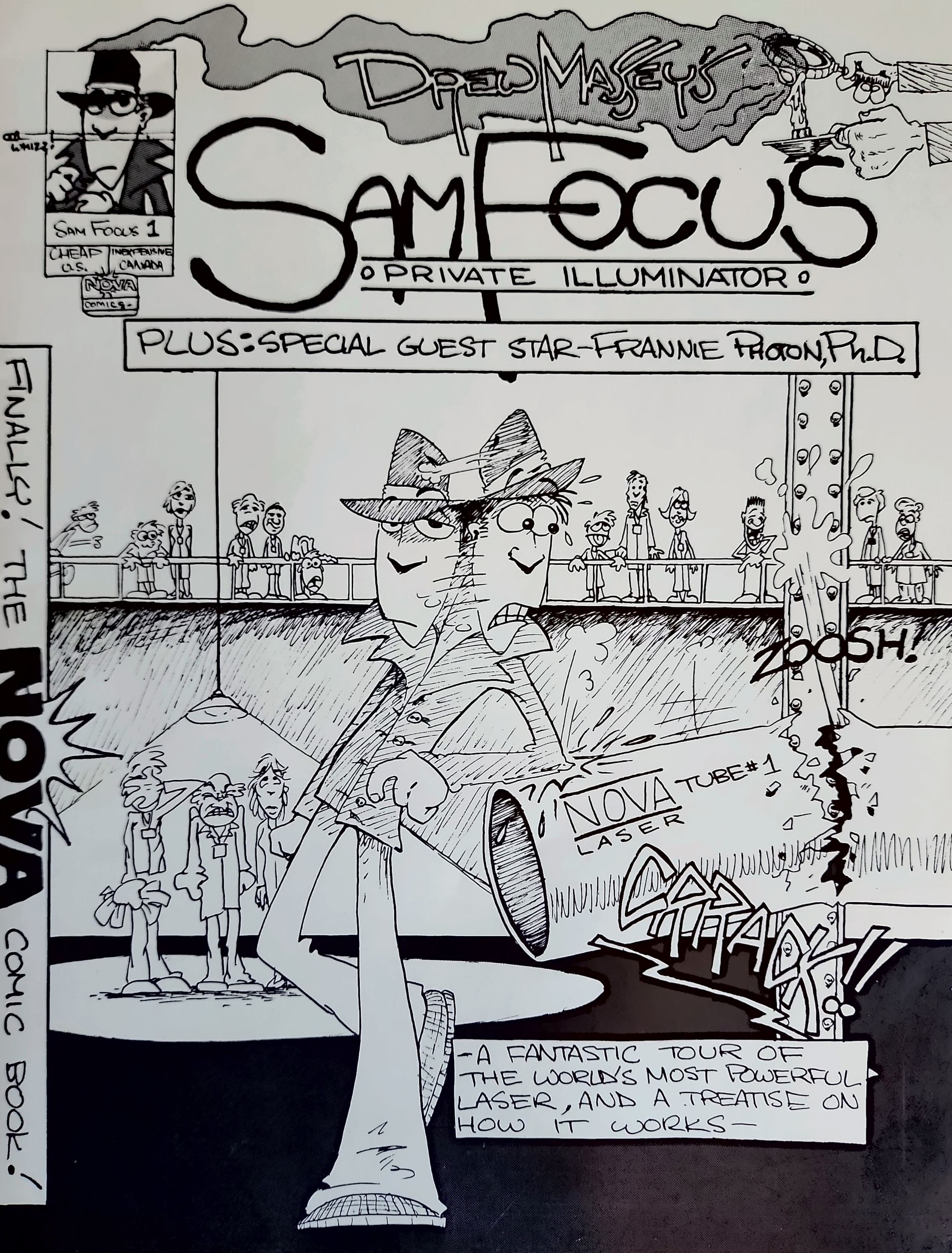

DREW MASSEY'S
SAM FOCUS
PRIVATE ILLUMINATOR
PLUS: SPECIAL GUEST STAR–FRANNIE PHOTON, Ph.D.
OOL WHIZZ!
SAM FOCUS 1
CHEAP U.S.
INEXPENSIVE CANADA
NOVA COMICS
FINALLY! THE NOVA COMIC BOOK!
ZOOSH!
NOVA LASER TUBE #1
CRRRACK!!
–A FANTASTIC TOUR OF THE WORLD'S MOST POWERFUL LASER, AND A TREATISE ON HOW IT WORKS–

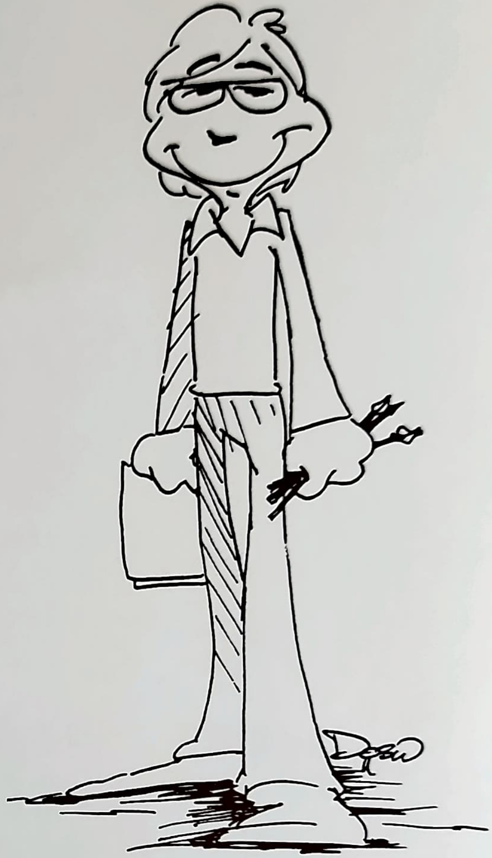
About the Artist

Born in San Francisco, Drew Massey is currently 15 years old and resides in Livermore with his parents. A sophomore at Granada High School, Drew started drawing when he was four years old. "I got interested in drawing by reading comic books," he says, "We moved a lot so my folks would buy comic books to amuse me during the long car trips to each new home. First I would read the comic books, then I would draw the characters in them."

Where does he begin? "When drawing a face," Drew said, "I draw the eyes first. They are the most expressive part of the face. And then I go on from there....Sometimes I have an idea for an entire composition, the entire picture," he said, "and sometimes I experiment, not really knowing how a picture is going to turn out."

To create Sam Focus, Drew started with the hat, a typical detective hat and trench coat. "I was experimenting with that sort of nose and face," Drew says, "mostly ad-libbing it." For Frannie Photon, Drew tried to make her look intellectual and feminine.

All totaled, Drew estimates it took him about 80 hours to draw the comic book during a two-month period. "I enjoyed doing it, it was fun experimenting," he says, "and I'm glad I've got it done!"



THE NOVA COMIC BOOK

Artwork and Story: Drew Massey

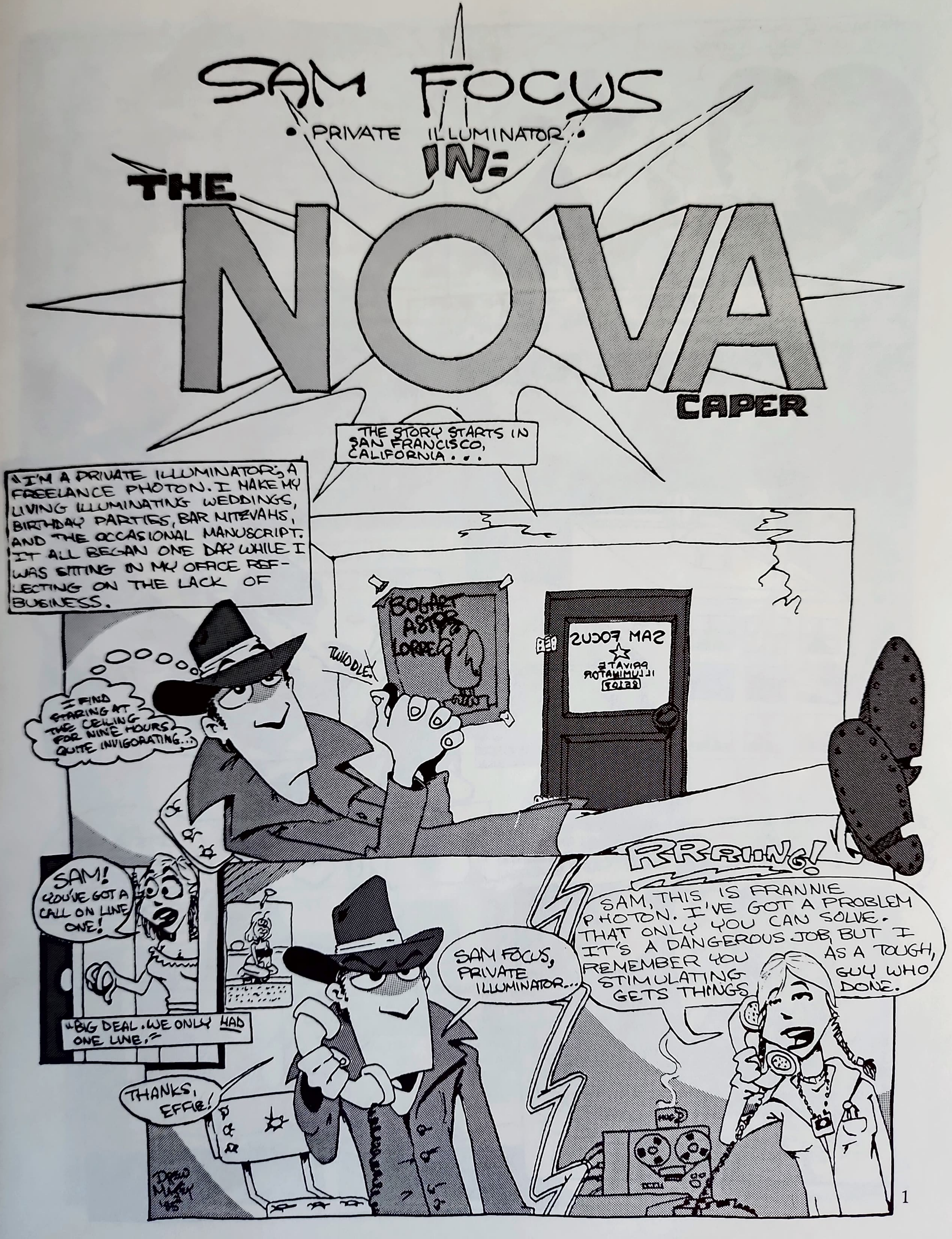
Story:	S. Massey
Production:	S. Dougherty
Concept:	R. Godwin S. Stephenson

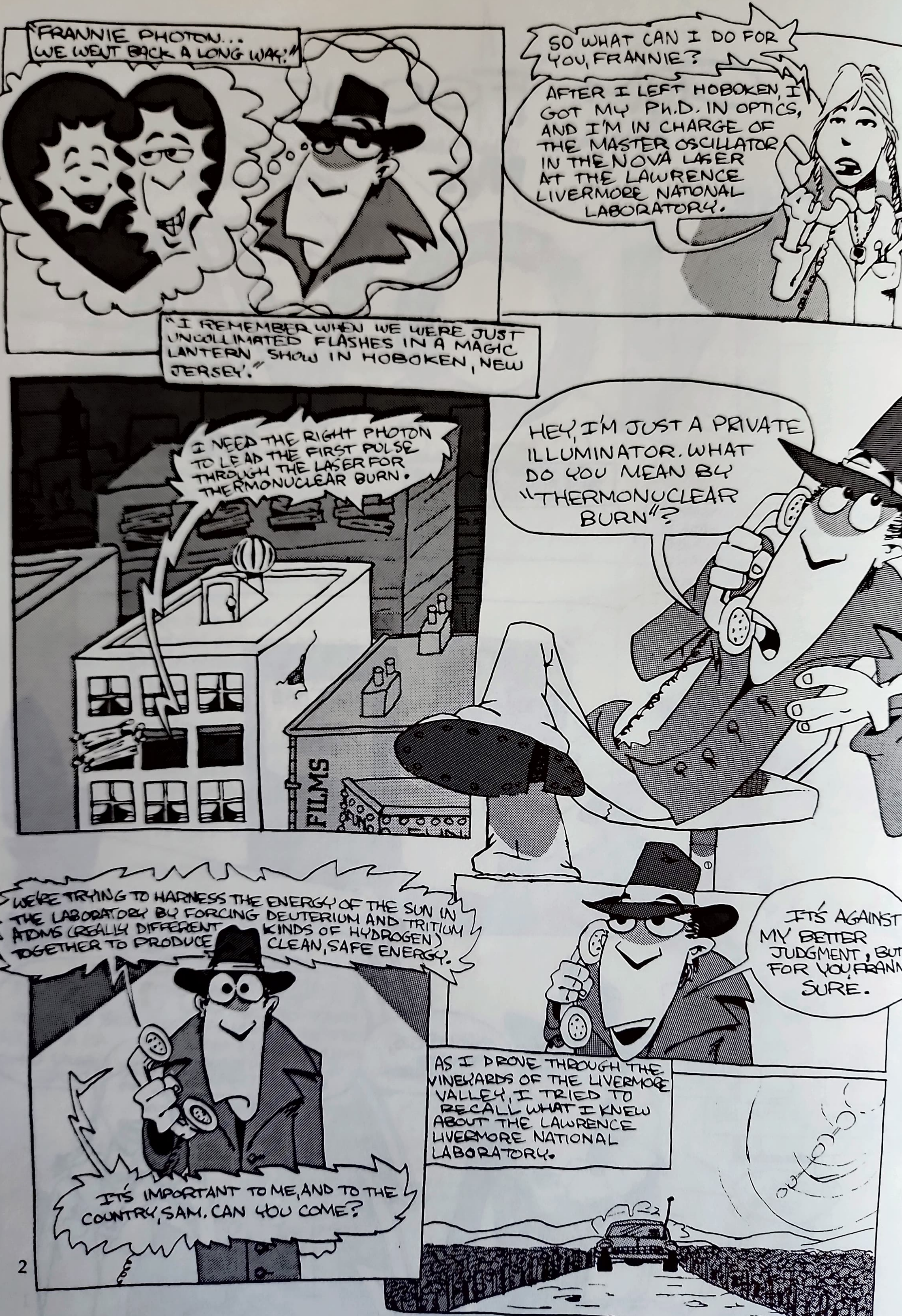
THE NOVA LASER

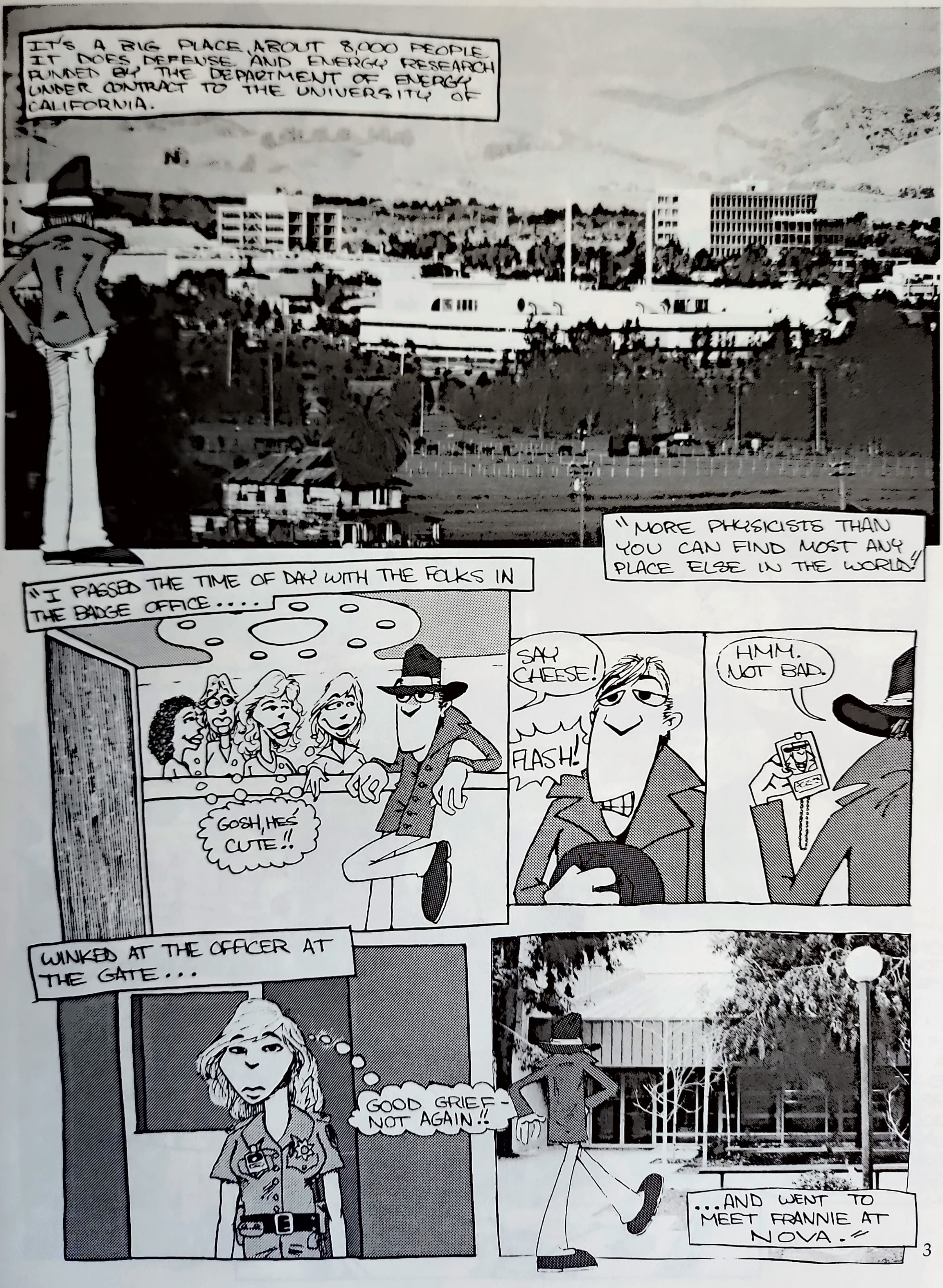
A cast of hundreds of dedicated workers

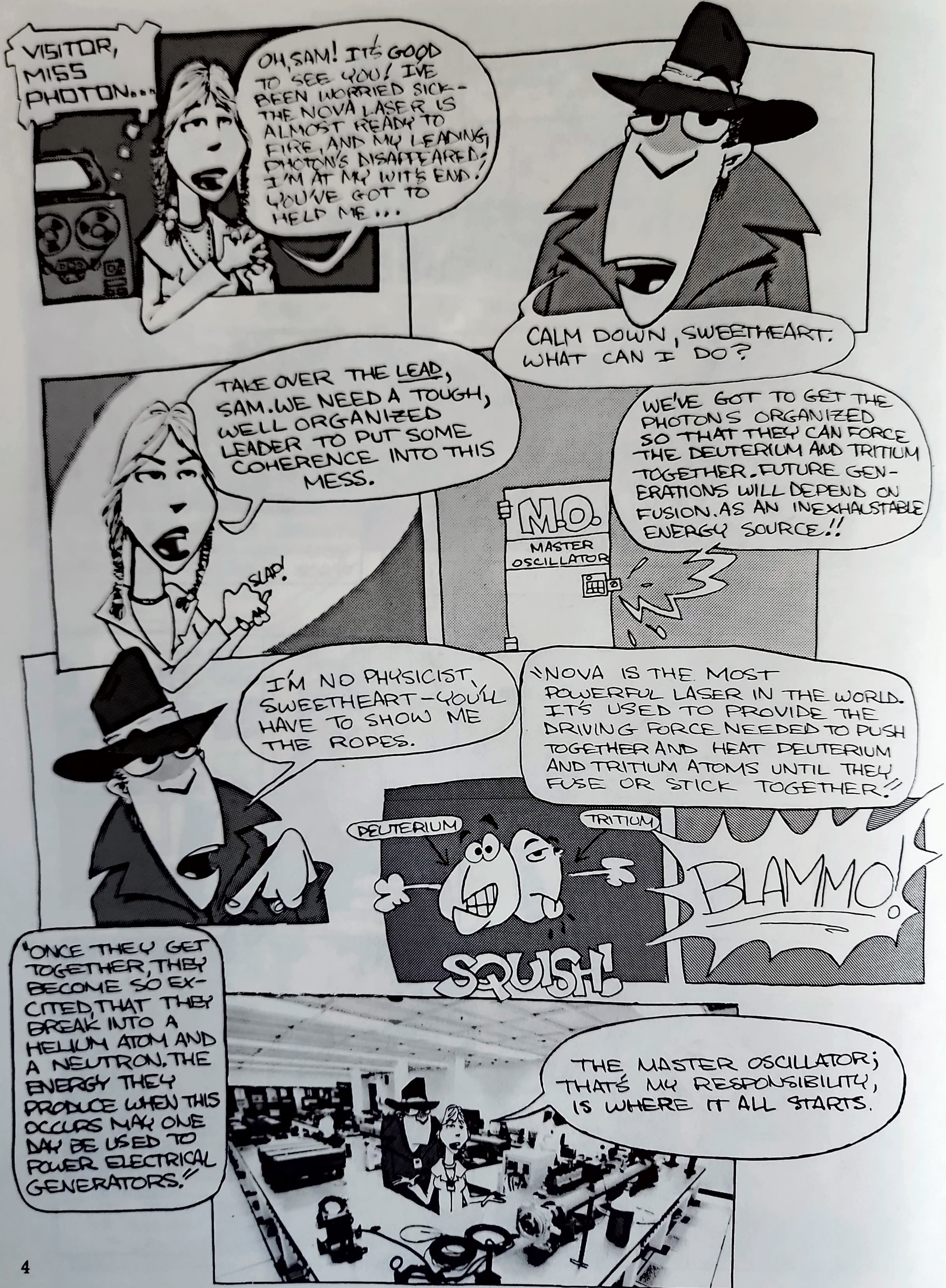
DISCLAIMER

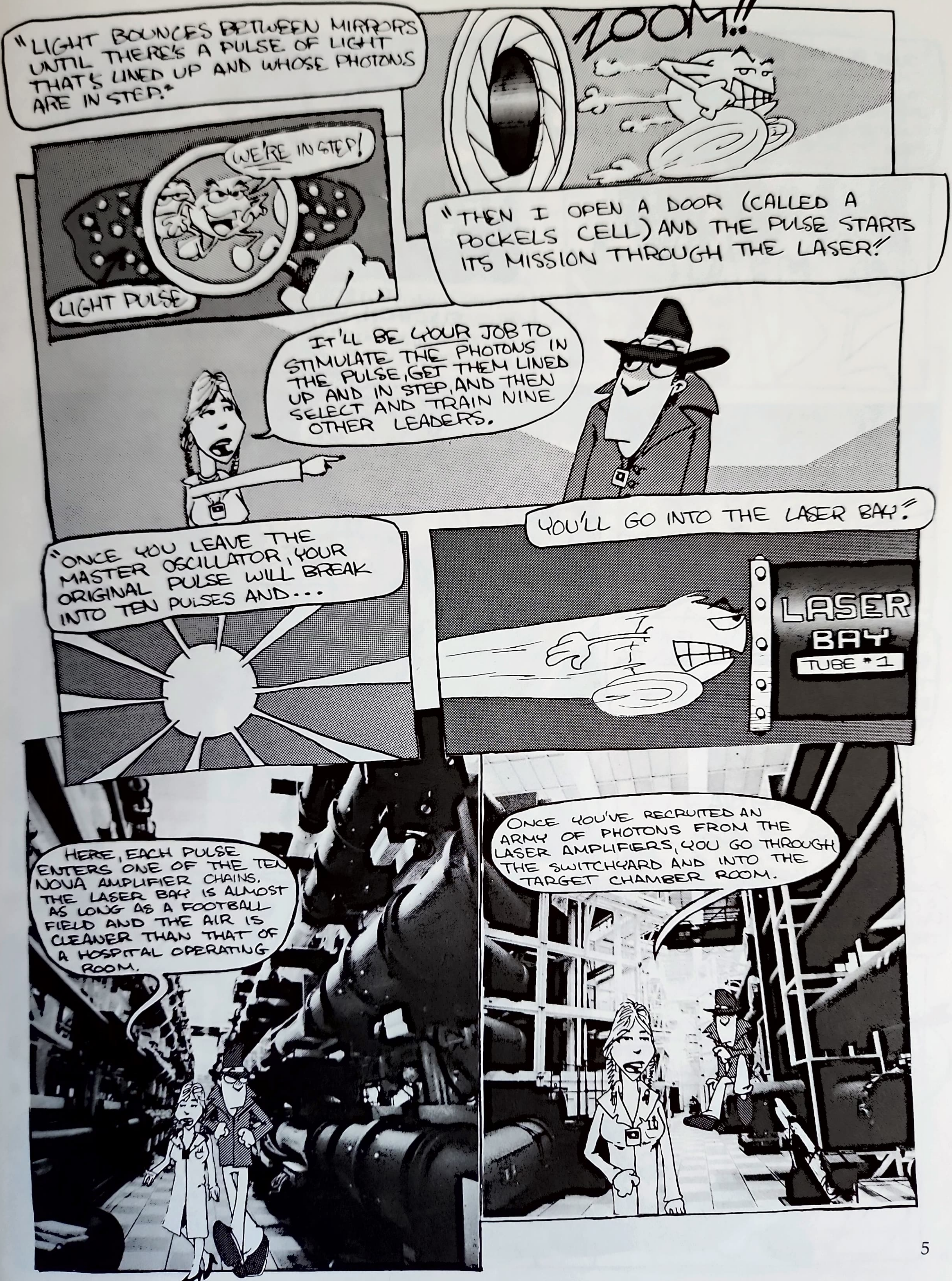
The Lawrence Livermore National Laboratory is funded by the Department of Energy and managed by the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government nor the University of California.

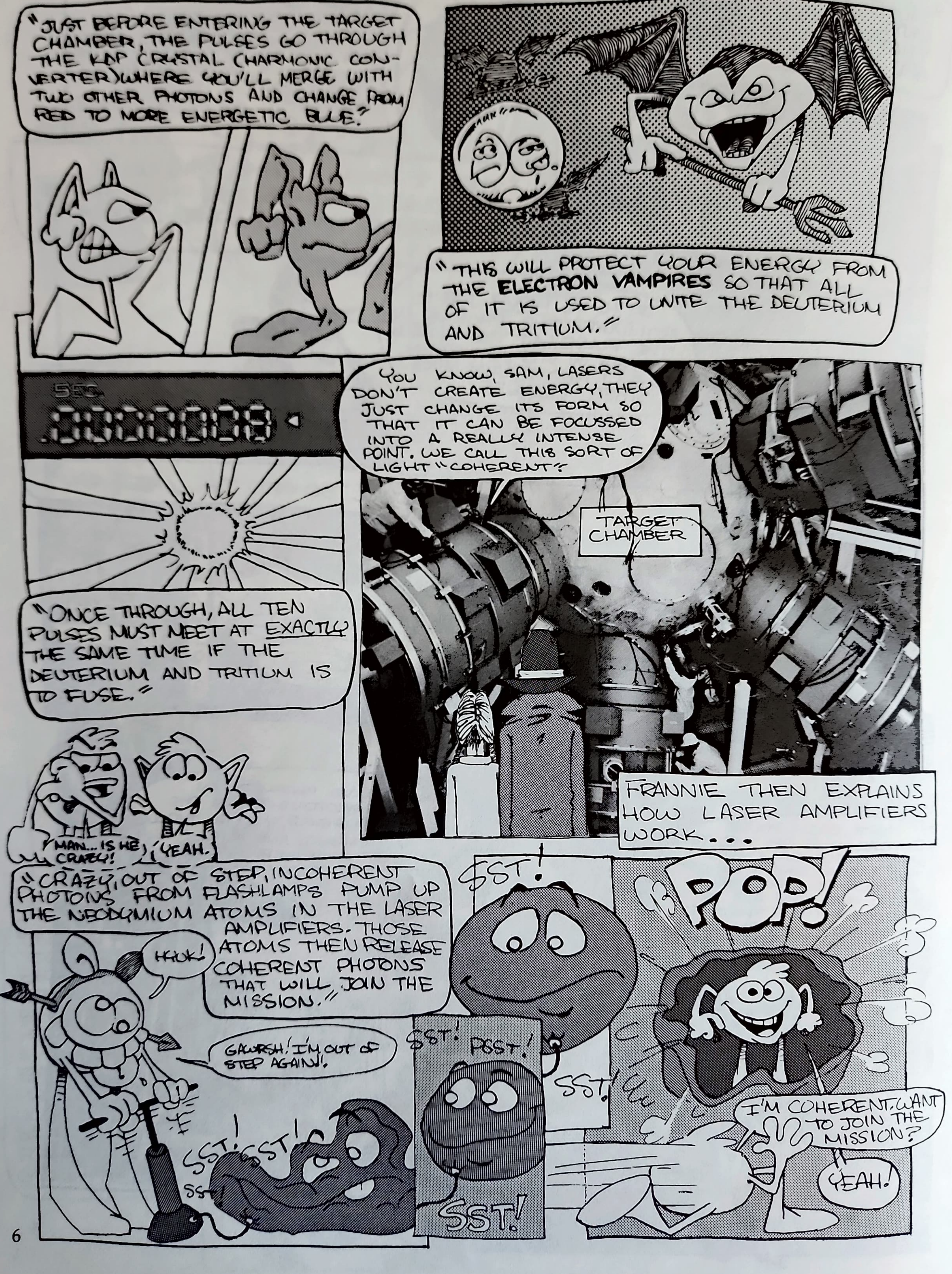

SAM FOCUS
• PRIVATE ILLUMINATOR •
IN:
THE NOVA CAPER
THE STORY STARTS IN SAN FRANCISCO, CALIFORNIA . . .
"I'M A PRIVATE ILLUMINATOR; A FREELANCE PHOTON. I MAKE MY LIVING ILLUMINATING WEDDINGS, BIRTHDAY PARTIES, BAR MITZVAHS, AND THE OCCASIONAL MANUSCRIPT. IT ALL BEGAN ONE DAY WHILE I WAS SITTING IN MY OFFICE REFLECTING ON THE LACK OF BUSINESS.
I FIND STARING AT THE CEILING FOR NINE HOURS QUITE INVIGORATING...
TWIDDLE.
BOGART ASTOR LORRE
SAM FOCUS
PRIVATE ILLUMINATOR
RRRING!
SAM! YOU'VE GOT A CALL ON LINE ONE!
"BIG DEAL. WE ONLY HAD ONE LINE."
THANKS, EFFIE!
SAM FOCUS, PRIVATE ILLUMINATOR...
SAM, THIS IS FRANNIE PHOTON. I'VE GOT A PROBLEM THAT ONLY YOU CAN SOLVE. IT'S A DANGEROUS JOB, BUT I REMEMBER YOU AS A TOUGH, STIMULATING GUY WHO GETS THINGS DONE.

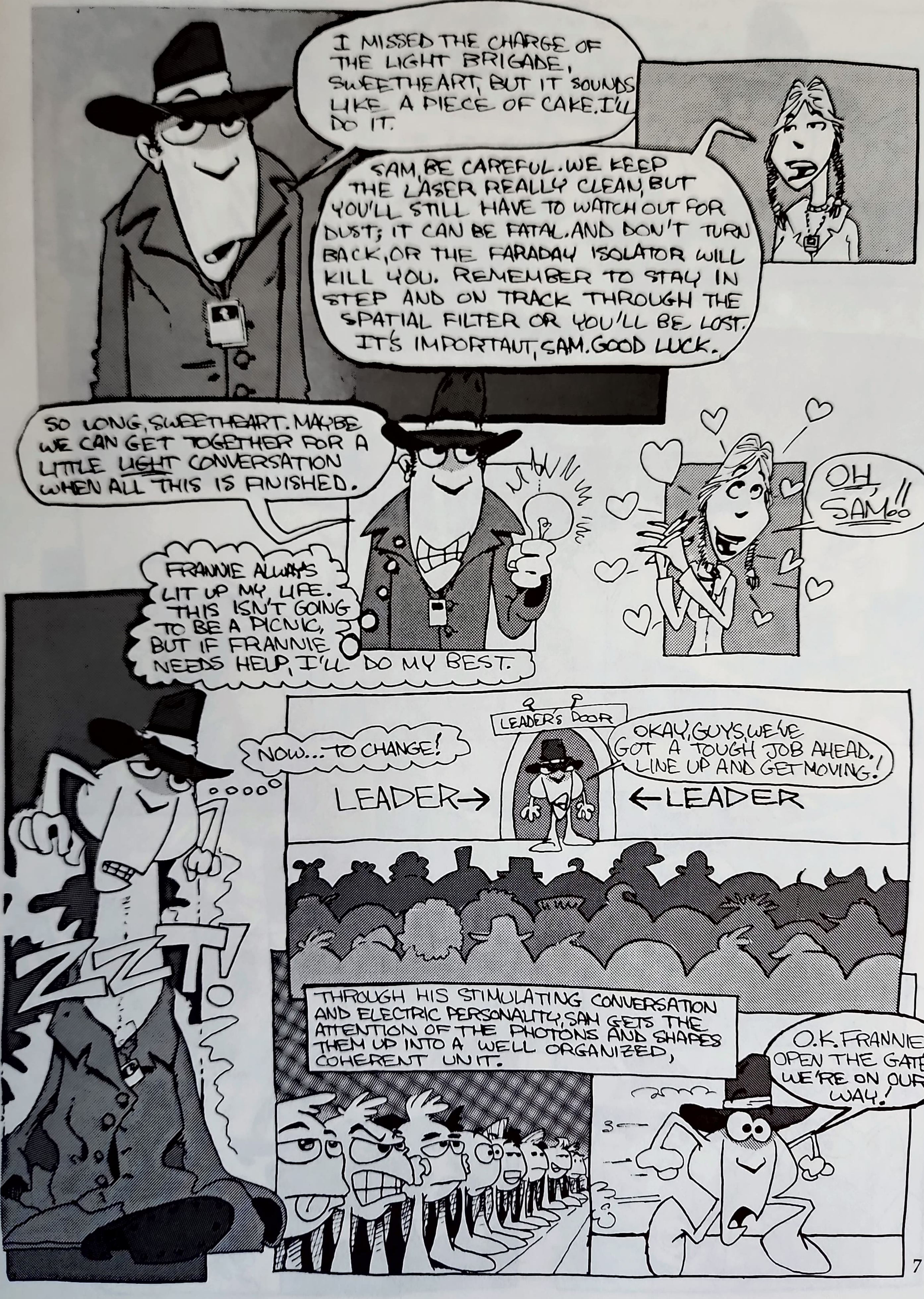

"FRANNIE PHOTON... WE WENT BACK A LONG WAY."
"I REMEMBER WHEN WE WERE JUST UNCOLLIMATED FLASHES IN A MAGIC LANTERN SHOW IN HOBOKEN, NEW JERSEY."
SO WHAT CAN I DO FOR YOU, FRANNIE?
AFTER I LEFT HOBOKEN, I GOT MY Ph.D. IN OPTICS, AND I'M IN CHARGE OF THE MASTER OSCILLATOR IN THE NOVA LASER AT THE LAWRENCE LIVERMORE NATIONAL LABORATORY.
I NEED THE RIGHT PHOTON TO LEAD THE FIRST PULSE THROUGH THE LASER FOR THERMONUCLEAR BURN.
FILMS
HEY, I'M JUST A PRIVATE ILLUMINATOR. WHAT DO YOU MEAN BY "THERMONUCLEAR BURN"?
WE'RE TRYING TO HARNESS THE ENERGY OF THE SUN IN THE LABORATORY BY FORCING DEUTERIUM AND TRITIUM ATOMS (REALLY DIFFERENT KINDS OF HYDROGEN) TOGETHER TO PRODUCE CLEAN, SAFE ENERGY.
IT'S IMPORTANT TO ME, AND TO THE COUNTRY, SAM. CAN YOU COME?
IT'S AGAINST MY BETTER JUDGMENT, BUT FOR YOU, FRANNIE, SURE.
AS I DROVE THROUGH THE VINEYARDS OF THE LIVERMORE VALLEY, I TRIED TO RECALL WHAT I KNEW ABOUT THE LAWRENCE LIVERMORE NATIONAL LABORATORY.

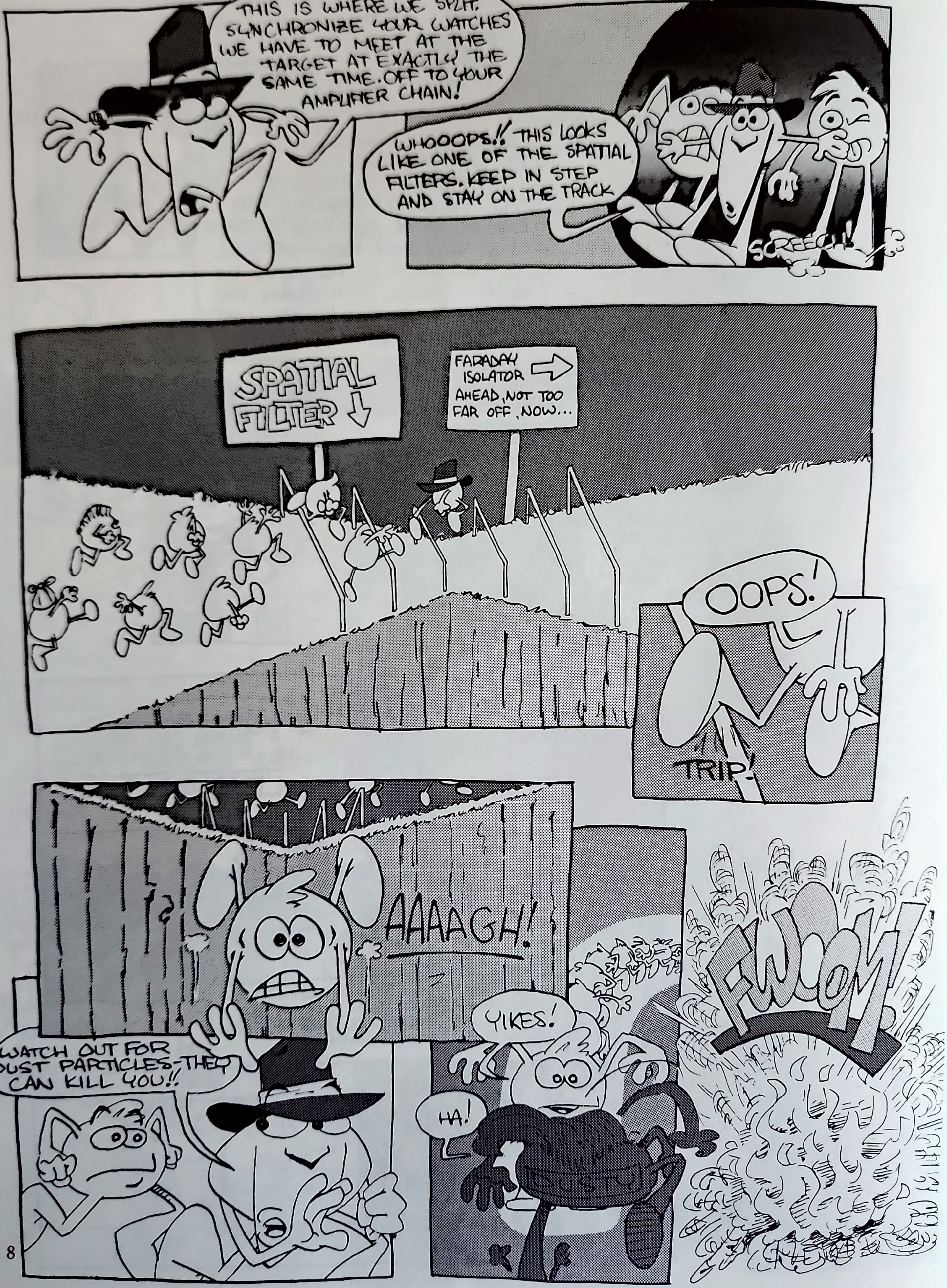

IT'S A BIG PLACE, ABOUT 8,000 PEOPLE. IT DOES DEFENSE AND ENERGY RESEARCH FUNDED BY THE DEPARTMENT OF ENERGY UNDER CONTRACT TO THE UNIVERSITY OF CALIFORNIA.
"MORE PHYSICISTS THAN YOU CAN FIND MOST ANY PLACE ELSE IN THE WORLD!!
"I PASSED THE TIME OF DAY WITH THE FOLKS IN THE BADGE OFFICE....
GOSH, HE'S CUTE!!
SAY CHEESE!
FLASH!
HMM. NOT BAD.
WINKED AT THE OFFICER AT THE GATE...
GOOD GRIEF - NOT AGAIN!!
E
...AND WENT TO MEET FRANNIE AT NOVA."

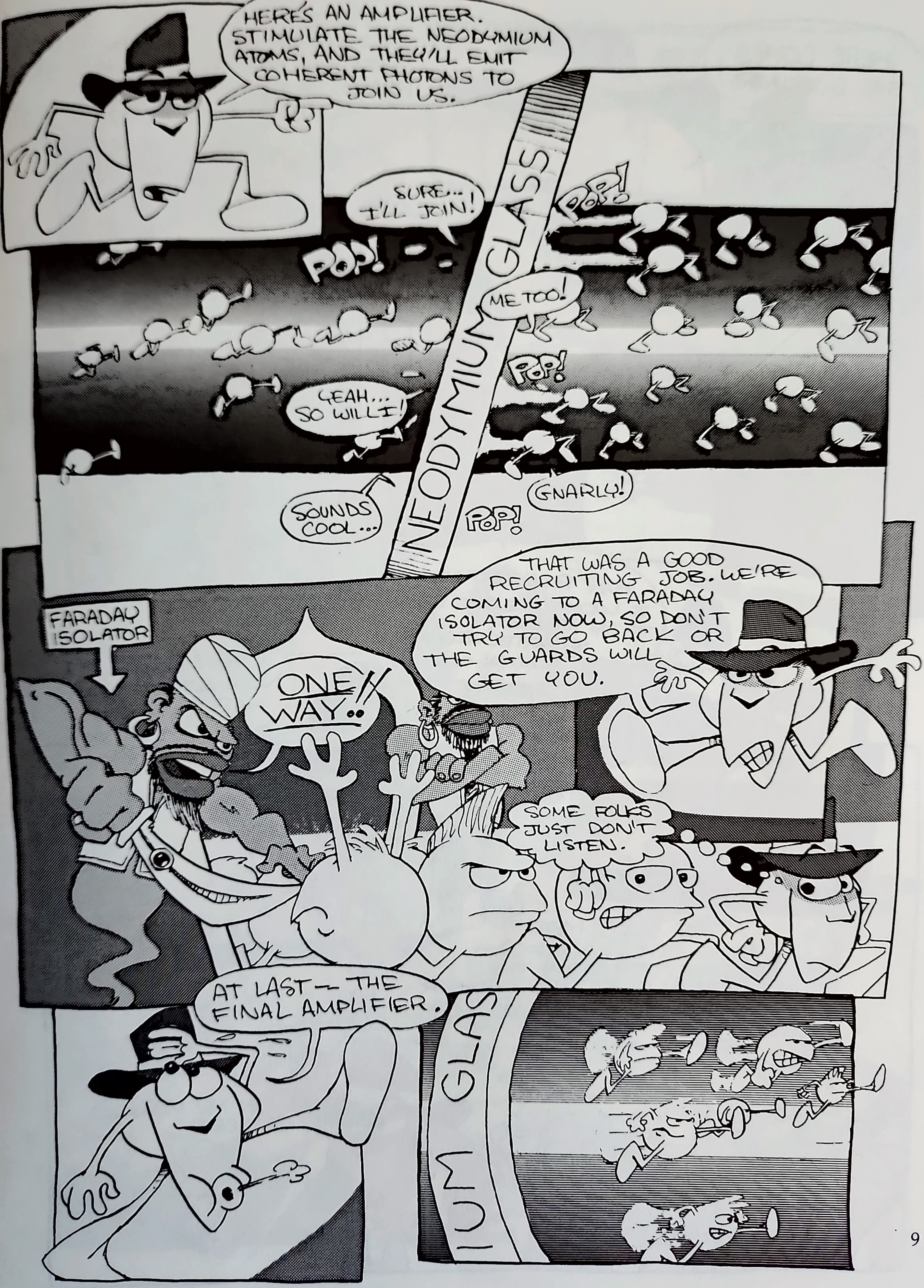

VISITOR, MISS PHOTON...
OH, SAM! IT'S GOOD TO SEE YOU! I'VE BEEN WORRIED SICK—THE NOVA LASER IS ALMOST READY TO FIRE, AND MY LEADING PHOTON'S DISAPPEARED! I'M AT MY WIT'S END! YOU'VE GOT TO HELP ME...
CALM DOWN, SWEETHEART. WHAT CAN I DO?
TAKE OVER THE LEAD, SAM. WE NEED A TOUGH, WELL ORGANIZED LEADER TO PUT SOME COHERENCE INTO THIS MESS.
SLAP!
WE'VE GOT TO GET THE PHOTONS ORGANIZED SO THAT THEY CAN FORCE THE DEUTERIUM AND TRITIUM TOGETHER. FUTURE GENERATIONS WILL DEPEND ON FUSION. AS AN INEXHAUSTABLE ENERGY SOURCE!!
M.O.
MASTER OSCILLATOR
I'M NO PHYSICIST, SWEETHEART—YOU'LL HAVE TO SHOW ME THE ROPES.
"NOVA IS THE MOST POWERFUL LASER IN THE WORLD. IT'S USED TO PROVIDE THE DRIVING FORCE NEEDED TO PUSH TOGETHER AND HEAT DEUTERIUM AND TRITIUM ATOMS UNTIL THEY FUSE OR STICK TOGETHER!"
DEUTERIUM
TRITIUM
BLAMMO!
SQUISH!
"ONCE THEY GET TOGETHER, THEY BECOME SO EXCITED, THAT THEY BREAK INTO A HELIUM ATOM AND A NEUTRON. THE ENERGY THEY PRODUCE WHEN THIS OCCURS MAY ONE DAY BE USED TO POWER ELECTRICAL GENERATORS!"
THE MASTER OSCILLATOR; THAT'S MY RESPONSIBILITY, IS WHERE IT ALL STARTS.

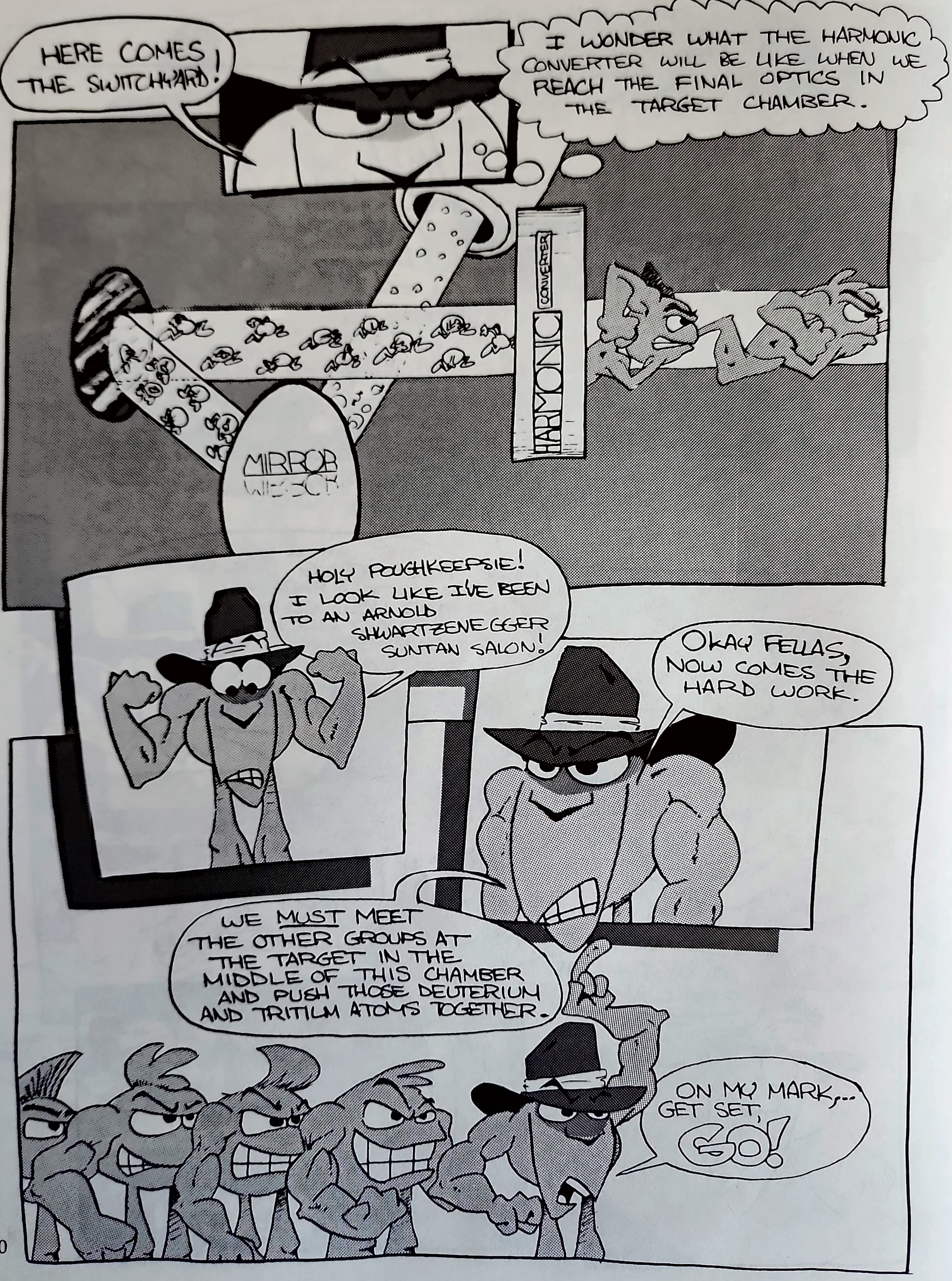

"LIGHT BOUNCES BETWEEN MIRRORS UNTIL THERE'S A PULSE OF LIGHT THAT'S LINED UP AND WHOSE PHOTONS ARE IN STEP."
ZOOM!!
WE'RE IN STEP!
LIGHT PULSE
"THEN I OPEN A DOOR (CALLED A POCKELS CELL) AND THE PULSE STARTS ITS MISSION THROUGH THE LASER!"
IT'LL BE YOUR JOB TO STIMULATE THE PHOTONS IN THE PULSE, GET THEM LINED UP AND IN STEP, AND THEN SELECT AND TRAIN NINE OTHER LEADERS.
"ONCE YOU LEAVE THE MASTER OSCILLATOR, YOUR ORIGINAL PULSE WILL BREAK INTO TEN PULSES AND...
YOU'LL GO INTO THE LASER BAY!"
LASER BAY
TUBE #1
HERE, EACH PULSE ENTERS ONE OF THE TEN NOVA AMPLIFIER CHAINS. THE LASER BAY IS ALMOST AS LONG AS A FOOTBALL FIELD AND THE AIR IS CLEANER THAN THAT OF A HOSPITAL OPERATING ROOM.
ONCE YOU'VE RECRUITED AN ARMY OF PHOTONS FROM THE LASER AMPLIFIERS, YOU GO THROUGH THE SWITCHYARD AND INTO THE TARGET CHAMBER ROOM.

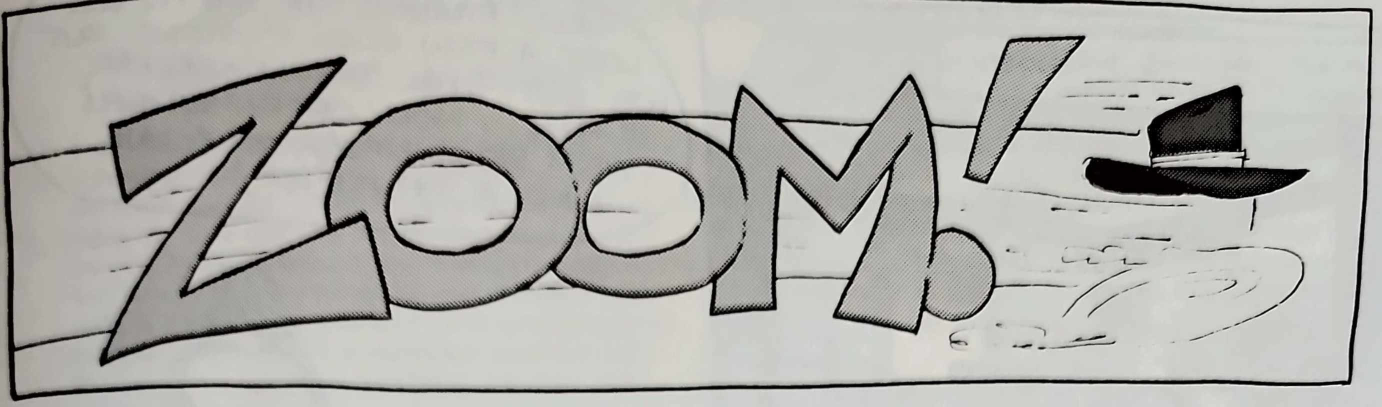

"JUST BEFORE ENTERING THE TARGET CHAMBER, THE PULSES GO THROUGH THE KDP CRYSTAL (HARMONIC CONVERTER) WHERE YOU'LL MERGE WITH TWO OTHER PHOTONS AND CHANGE FROM RED TO MORE ENERGETIC BLUE."
"THIS WILL PROTECT YOUR ENERGY FROM THE **ELECTRON VAMPIRES** SO THAT ALL OF IT IS USED TO UNITE THE DEUTERIUM AND TRITIUM."
SEC
.0000008
"ONCE THROUGH, ALL TEN PULSES MUST MEET AT EXACTLY THE SAME TIME IF THE DEUTERIUM AND TRITIUM IS TO FUSE."
YOU KNOW, SAM, LASERS DON'T CREATE ENERGY, THEY JUST CHANGE ITS FORM SO THAT IT CAN BE FOCUSSED INTO A REALLY INTENSE POINT. WE CALL THIS SORT OF LIGHT "COHERENT".
TARGET CHAMBER
FRANNIE THEN EXPLAINS HOW LASER AMPLIFIERS WORK...
MAN... IS HE CRAZY!
YEAH.
"CRAZY, OUT OF STEP, INCOHERENT PHOTONS FROM FLASHLAMPS PUMP UP THE NEODYMIUM ATOMS IN THE LASER AMPLIFIERS. THOSE ATOMS THEN RELEASE COHERENT PHOTONS THAT WILL JOIN THE MISSION."
HYUK!
GAWRSH! I'M OUT OF STEP AGAIN!
SST!
SST!
SST!
SS-
SST!
PSST!
SST!
SST!
POP!
I'M COHERENT. WANT TO JOIN THE MISSION?
YEAH!

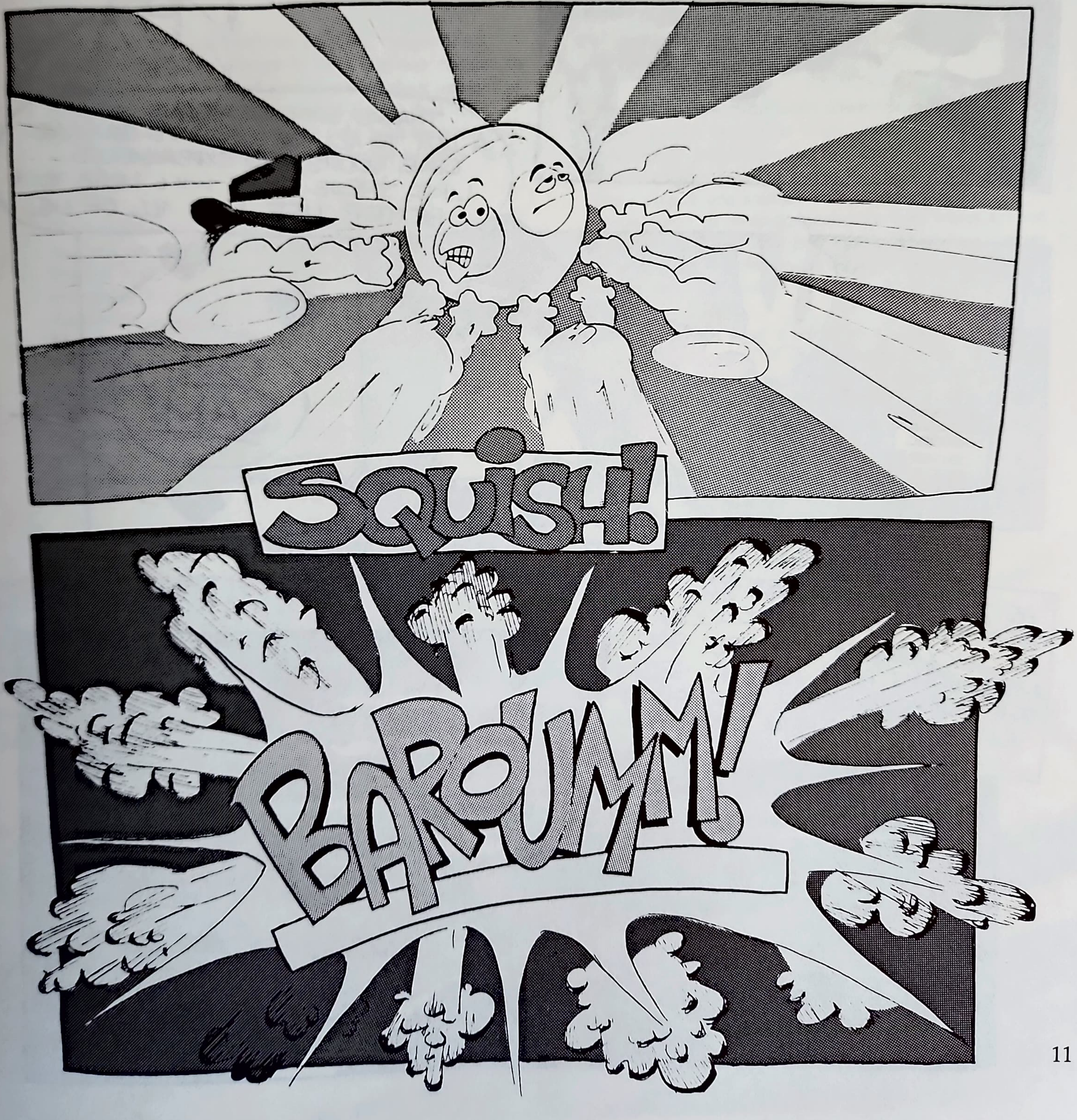

I MISSED THE CHARGE OF THE LIGHT BRIGADE, SWEETHEART, BUT IT SOUNDS LIKE A PIECE OF CAKE. I'LL DO IT.
SAM, BE CAREFUL. WE KEEP THE LASER REALLY CLEAN, BUT YOU'LL STILL HAVE TO WATCH OUT FOR DUST; IT CAN BE FATAL. AND DON'T TURN BACK, OR THE FARADAY ISOLATOR WILL KILL YOU. REMEMBER TO STAY IN STEP AND ON TRACK THROUGH THE SPATIAL FILTER OR YOU'LL BE LOST. IT'S IMPORTANT, SAM. GOOD LUCK.
SO LONG, SWEETHEART. MAYBE WE CAN GET TOGETHER FOR A LITTLE LIGHT CONVERSATION WHEN ALL THIS IS FINISHED.
OH, SAM!!
FRANNIE ALWAYS LIT UP MY LIFE. THIS ISN'T GOING TO BE A PICNIC, BUT IF FRANNIE NEEDS HELP, I'LL DO MY BEST.
NOW... TO CHANGE!
ZZZT!
LEADER'S DOOR
OKAY, GUYS, WE'VE GOT A TOUGH JOB AHEAD. LINE UP AND GET MOVING!
LEADER→
←LEADER
THROUGH HIS STIMULATING CONVERSATION AND ELECTRIC PERSONALITY, SAM GETS THE ATTENTION OF THE PHOTONS AND SHAPES THEM UP INTO A WELL ORGANIZED, COHERENT UNIT.
O.K. FRANNIE, OPEN THE GATE- WE'RE ON OUR WAY!

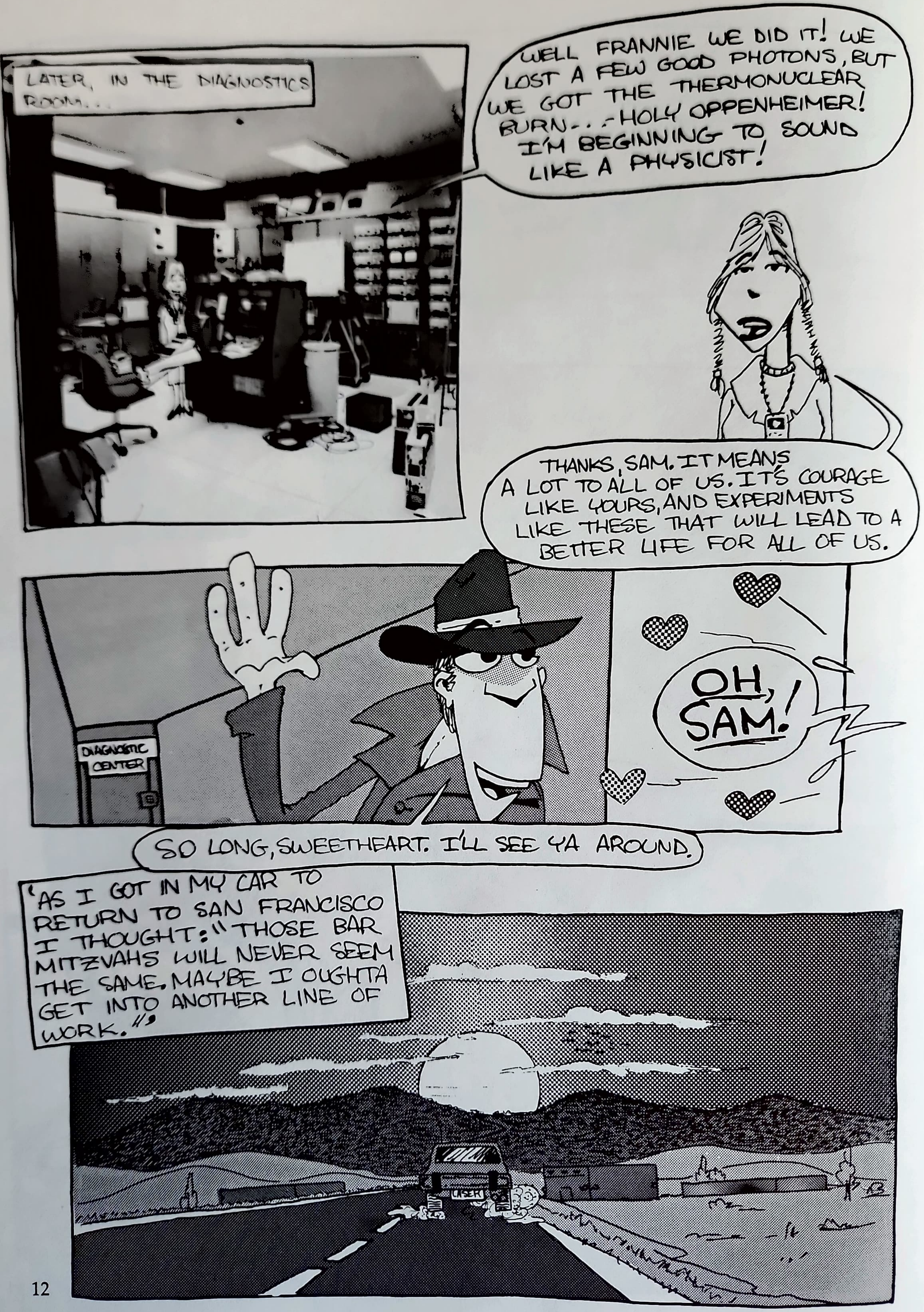

THIS IS WHERE WE SPLIT. SYNCHRONIZE YOUR WATCHES WE HAVE TO MEET AT THE TARGET AT EXACTLY THE SAME TIME. OFF TO YOUR AMPLIFIER CHAIN!
WHOOOPS!! THIS LOOKS LIKE ONE OF THE SPATIAL FILTERS. KEEP IN STEP AND STAY ON THE TRACK
SCREECH!
SPATIAL FILTER
FARADAY ISOLATOR AHEAD, NOT TOO FAR OFF, NOW...
OOPS!
TRIP!
?
AAAAGH!
WATCH OUT FOR DUST PARTICLES-THEY CAN KILL YOU!!
YIKES!
HA!
DUSTY
FWOOM!


HERE'S AN AMPLIFIER. STIMULATE THE NEODYMIUM ATOMS, AND THEY'LL EMIT COHERENT PHOTONS TO JOIN US.
NEODYMIUM GLASS
SURE... I'LL JOIN!
POP!
POP!
ME TOO!
POP!
YEAH... SO WILL I!
SOUNDS COOL...
POP!
GNARLY!
FARADAY ISOLATOR
ONE WAY..!!
THAT WAS A GOOD RECRUITING JOB. WE'RE COMING TO A FARADAY ISOLATOR NOW, SO DON'T TRY TO GO BACK OR THE GUARDS WILL GET YOU.
SOME FOLKS JUST DON'T LISTEN.
AT LAST — THE FINAL AMPLIFIER.
IUM GLAS


HERE COMES THE SWITCHYARD!
I WONDER WHAT THE HARMONIC CONVERTER WILL BE LIKE WHEN WE REACH THE FINAL OPTICS IN THE TARGET CHAMBER.
HARMONIC CONVERTER
MIRROR
HOLY POUGHKEEPSIE! I LOOK LIKE I'VE BEEN TO AN ARNOLD SHWARTZENEGGER SUNTAN SALON!
OKAY FELLAS, NOW COMES THE HARD WORK.
WE MUST MEET THE OTHER GROUPS AT THE TARGET IN THE MIDDLE OF THIS CHAMBER AND PUSH THOSE DEUTERIUM AND TRITIUM ATOMS TOGETHER.
ON MY MARK,... GET SET, GO!


ZOOM!


SQUISH!
BAROUMM!


LATER, IN THE DIAGNOSTICS ROOM...
WELL FRANNIE WE DID IT! WE LOST A FEW GOOD PHOTONS, BUT WE GOT THE THERMONUCLEAR BURN...-HOLY OPPENHEIMER! I'M BEGINNING TO SOUND LIKE A PHYSICIST!
THANKS, SAM. IT MEANS A LOT TO ALL OF US. IT'S COURAGE LIKE YOURS, AND EXPERIMENTS LIKE THESE THAT WILL LEAD TO A BETTER LIFE FOR ALL OF US.
DIAGNOSTIC CENTER
OH, SAM!
SO LONG, SWEETHEART. I'LL SEE YA AROUND.
'AS I GOT IN MY CAR TO RETURN TO SAN FRANCISCO I THOUGHT: "THOSE BAR MITZVAHS WILL NEVER SEEM THE SAME. MAYBE I OUGHTA GET INTO ANOTHER LINE OF WORK."'
LASER

HOW NOVA REALLY WORKS...

HOW NOVA REALLY WORKS...

Sam's odyssey through the Nova laser, although fantasy, is based on fact. There really is a group of scientists at the Lawrence Livermore National Laboratory who are using the Nova laser in a number of areas of scientific research including learning how to create a miniature sun and harness its fusion energy for use on earth. There really is a master laser oscillator which generates a very carefully designed pulse of light that's amplified and focused onto a tiny target containing deuterium and tritium.

PRELIMINARY THOUGHTS

First, as Frannie comments on page six, "lasers don't create energy." They change its form into one that can be focused onto a very small spot in a very short amount of time. This extreme concentration of a great deal of energy allows scientists to create very high temperatures in small targets, temperatures comparable to those found in the sun.

Nova is the latest in a series of increasingly powerful research lasers. (The room containing the Nova laser chain is nearly the length of a football field, the room containing the target chamber is five stories high.) Nova, the world's most powerful laser, is used at the Lawrence Livermore National Laboratory to study what happens when light interacts with matter and generates these high temperatures.

Experiments performed with Nova help scientists understand the physics processes which underlie the nation's defense technologies.

Although Nova will never produce electricity, the knowledge scientists gain from experiments with it will also help them to eventually harness high temperature reactions between deuterium and tritium, an energy source similar to that of the sun. This approach to harnessing fusion energy, which uses a laser to heat the small fuel pellet, is called "inertial confinement fusion" or ICF. This can potentially provide a clean, abundant source of energy for the world.

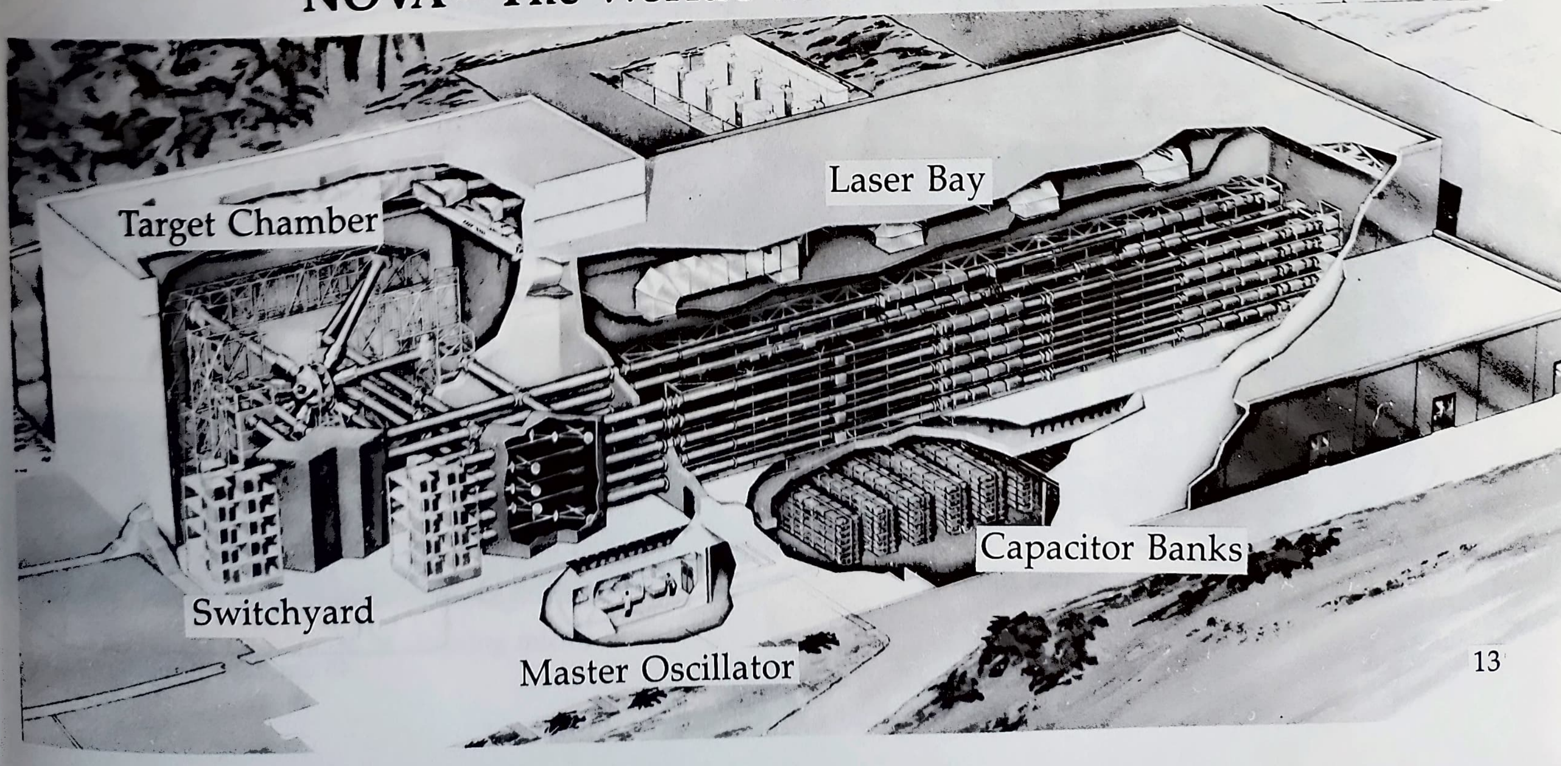
SPEAKING COHERENTLY

Sam and Frannie both have their fictional origins as photons, the smallest individual unit of light. Although they've both gone on to bigger things, Sam retains the ability to transform himself back to his earlier identity as a photon.

Sam and Frannie make jokes about optical terms throughout the story. One of the terms frequently used is "coherence"...very important to those who use lasers. Coherent light consist of waves that have a fixed relationship to one another or in other words are synchronized. In contrast, incoherent light waves are not synchronized. Laser light is coherent. When Sam worries about keeping the photons in step, he's worrying about keeping them coherent.

The photographs used in Sam's adventure were taken of the real Nova laser. The artist's drawing (page 13) and the schematic of an amplifier chain (pages 14–15) show how Nova's components are arranged and the path of a laser pulse.

NOVA – The World's Most Powerful Laser



Two activities converge to make a laser shot possible... the laser amplifier material must be energized and a master pulse of coherent light must be formed to trigger the release of energy from the amplifiers as the pulse passes through them.

ENERGIZING THE LASER

On page six, Frannie tells Sam that the neodymium atoms in the laser amplifier glass are pumped up (energized) by incoherent photons. This happens in Nova when the electrical energy stored in the capacitor banks in the basement is discharged into flashlamps in the laser amplifiers. The flashlamps produce an intense flash of incoherent light which adds energy to the neodymium atoms in the laser amplifier glass. When the laser pulse goes through the amplifier glass, these excited neodymium atoms give up their extra energy as coherent light. This light joins the master pulse, adding to its energy.

It takes about half a minute to charge the capacitors from the electrical power lines, and the flashlamp flash lasts about a thousandth of a second. The capacitors and flashlamps are a lot like a strobe flash on a camera... except they're a great deal larger.

PREPARING THE MASTER PULSE

As the flashlamps are pumping the neodymium glass, a very carefully crafted, low energy pulse of coherent light is prepared in the laser master oscillator room. This pulse of light is only a few billionths of a second long.

SPLITTING THE PULSE

The master pulse is admitted to the laser chain by an electro-optical device called a Pockels cell, an optical shutter which becomes transparent when it receives a triggering electrical signal.

Because the Nova laser has ten arms, it's necessary to divide the original pulse into ten identical pulses—one for each arm. Each of the ten powerful laser pulses used to make laser fusion starts as one of these rather weak pulses.

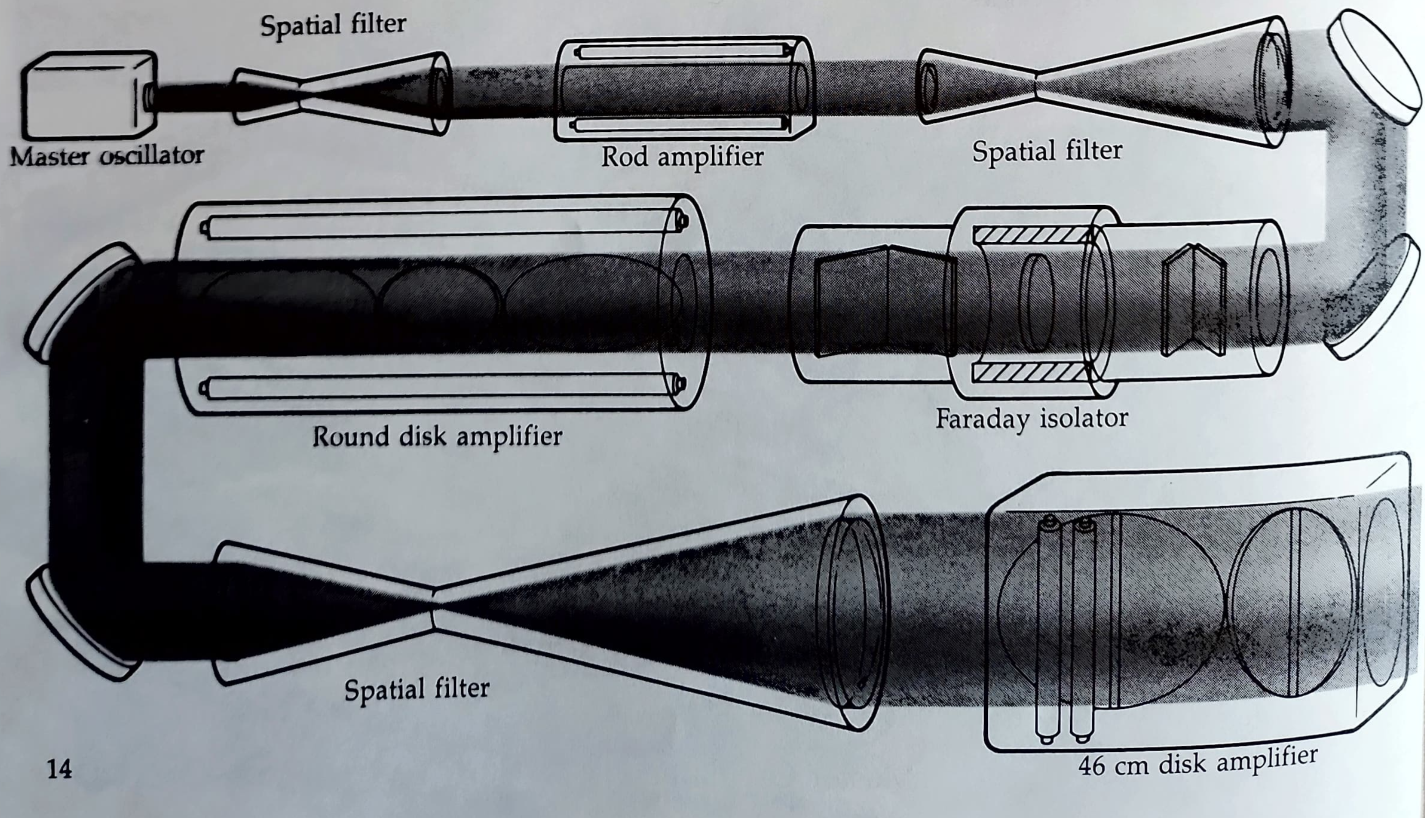
AMPLIFICATION

As each pulse goes through an amplifier (glass disk treated with neodymium atoms), neodymium atoms that have been "pumped up" by the flashlamps drop back to a lower energy state and surrender the extra energy as coherent light. This light joins the original pulse, making it more powerful. Each of the 16 amplifiers along a Nova arm increases the energy of the laser pulse that passes through it 2—20 times.

PROTECTING THE LASER

As the laser pulse becomes more powerful, it must be spread out over a larger surface to prevent damage to the glass disks, lenses, and mirrors in the laser system.

This beam spreading (enlargement) is achieved by using spatial filters. A relatively small beam is focused through a pinhole from which it expands to a larger diameter and then passes through another lens that directs the beam through the next amplifier.



Light which is not properly directed and focused is removed from the beam at the pinhole. The unfortunate photon shown on page eight had lost its direction or focus.

The Faraday isolator actually exists, although it differs from the fanciful representation on page nine. It's an optical one-way switch which allows light to go only forward through the laser chain, so that reflections are prevented from going backwards and causing damage to the laser components.

Dust, page nine, can be a real problem in large, high energy lasers. When a high energy laser pulse hits a particle of dust or dirt on a lens or other optical surface, it deposits its energy and causes a mini-explosion. This can damage the optical surface, and the damaged area can form a site for more mini-explosions. Eventually, the optical component could become damaged enough that it is no longer useful. This is why everyone works so hard to keep the Nova area super clean. In fact, a couple of Nova rooms are cleaner than a hospital operating room!

HARMONIC CONVERSION

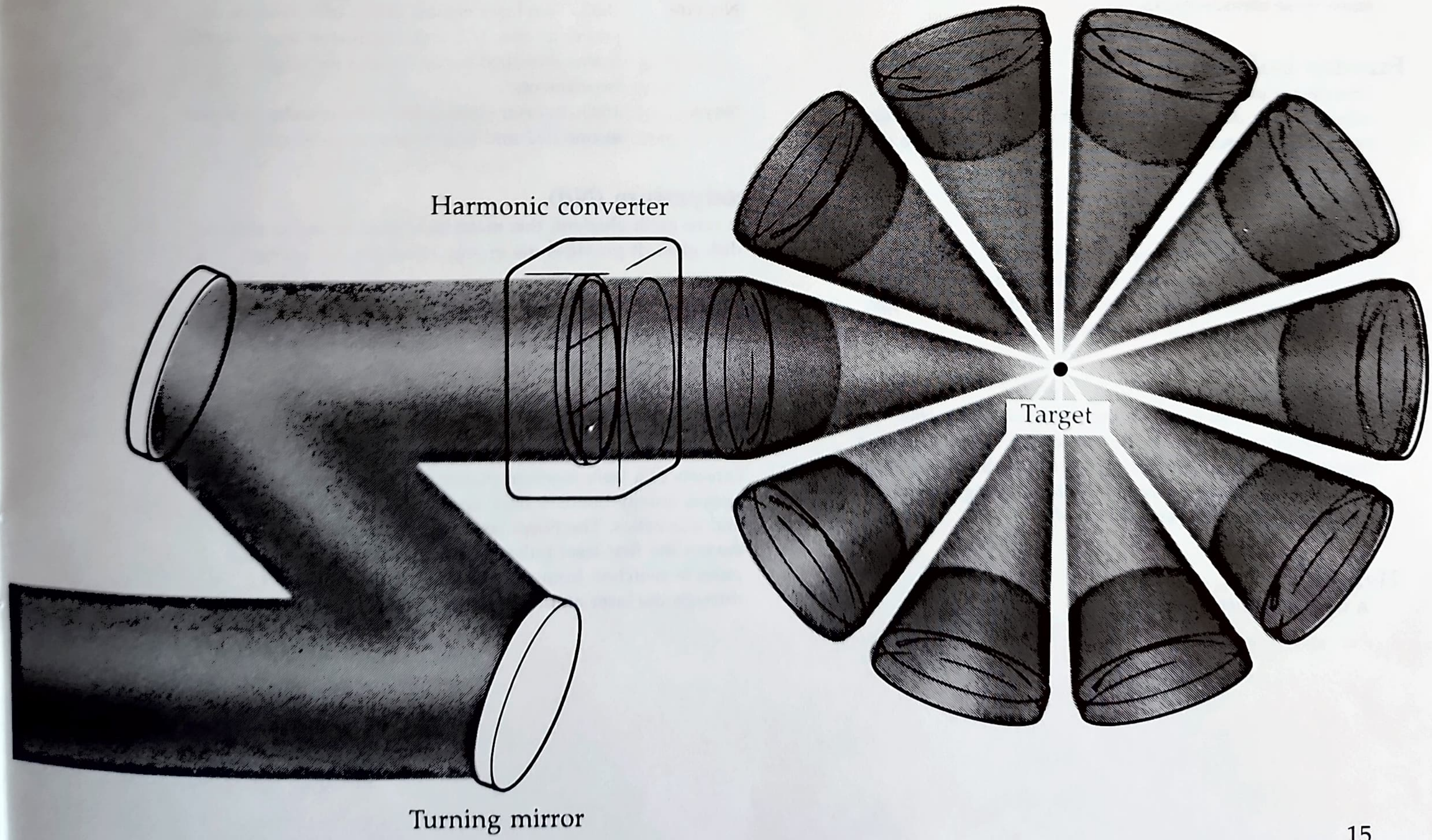
The harmonic converter that gives Sam his extra energy (page ten) is an important development in laser fusion. Neodymium lasers normally emit invisible infrared light with a wavelength of about a millionth of a meter. Experiments conducted at the Lawrence Livermore National Laboratory have shown that too much of the energy at this wavelength is transferred to electrons (vampire electrons, page six) and too little to the deuterium and tritium, and the targets don't work as well as they could.

Shorter wavelengths, one-half and one-third of a millionth of a meter (green and blue light) share less of their energy with the electrons and more with the deuterium and tritium, so the targets work better.

Scientists use a special crystal, potassium di-hydrogen phosphate (KDP) to convert the infrared light to green or blue light. Because the KDP doesn't create energy, and because green and blue photons have more energy than infrared photons, it takes two or more infrared photons to make a more energetic green or blue photon.

Finally, Sam and the other photons which comprise the laser pulse reach the target. The arrival time is critical and, in the real Nova, each of the ten pulses must arrive within much less than a billionth of a second of each other if the experiments are to be successful.

Sam's trip, in the real Nova, takes about a millionth of a second from the time he leaves the master oscillator until he arrives at the target.



Glossary

Amplifier
A component in the Nova laser which increases the energy of a pulse of coherent light that passes through it. Flashlamps surround rods or one-inch thick disks of glass containing neodymium ions. Light from the flashlamps excites the neodymium and the incoming pulse stimulates coherent emission of light from it. This makes the light more powerful. A laser chain (also called an arm) is a series of amplifiers and other components placed one after the other.

Atom
The smallest unit of matter which has a chemical identity. Atoms have a very heavy center, the nucleus, which is comprised of protons and neutrons. Electrons orbit the nucleus. The number of protons determines the chemical characteristics of the atom or element.

Coherent Light
Coherent light consists of waves in a fixed relationship to one another, synchronized with one another. In contrast, incoherent light waves are not synchronized. Laser light is coherent.

Deuterium
A form of the atom or element hydrogen. Deuterium is sometimes called heavy hydrogen. Its nucleus has one proton and one neutron. Deuterium can easily be found in water, making it an abundant fuel for fusion energy.

Diagnostics
The measurements taken on experiments conducted with the Nova laser. This term also refers to the instruments used to make these measurements.

Faraday Isolator
This device protects a laser amplifier chain against light reflected back through it. It does this by allowing the laser beam to pass through in only one direction. It is also called a Faraday Rotator.

Flashlamp
This is a powerful incoherent light source which pumps up the neodymium in the laser amplifier. Some of the energy stored in the neodymium is released and makes the laser pulse more powerful as it passes through.

Fusion
A nuclear reaction in which the nuclei of light atoms (deuterium and tritium in the case of the Nova laser) fuse together to form a new nuclear species (helium) and in the process they release energy in the form of high-speed particles (helium ions and neutrons).

Helium
A light weight chemical element.

ICF
This is an acronym which means Inertial Confinement Fusion. It is a fusion process in which the fuel is confined by its own inertia for a long enough time (several trillionths of a second) at high enough density and temperature that the fusion reactions take place.

Ion
An electrically charged atom, usually generated by removing one or more of its electrons.

KDP Crystal
On the Nova laser, KDP (potassium dihydrogen phosphate) crystals convert the infrared laser pulse to shorter wavelengths of green and ultraviolet light.

LASER
This is an acronym which means Light Amplification by Stimulated Emission of Radiation.

Laser systems at the Lawrence Livermore National Laboratory

Janus	1974, Two laser chains, 0.4 trillion watts of power at one-micron wavelength.
Cyclops	1975, One laser chain, 0.6 trillion watts of power at one-micron wavelength, it was a prototype for the Shiva laser.
Argus	1976, Two laser chains, 5.0 trillion watts of power at one-micron wavelength, reduced power at 1/2 and 1/3 micron wavelengths.
Shiva	1977, 20 laser chains, 20–30 trillion watts of power at one-micron wavelength.
Novette	1982, Two laser chains, 20–30 trillion watts of power at one, 1/2, and 1/4 micron wavelengths, it was a testbed for Nova and for target experiments.
Nova	1985, 10 laser chains, 100 trillion watts of power at one, 1/2 and 1/3 micron wavelengths.

Neodymium (Nd)
A rare-earth element, this material is used in the amplifier disk glass. It provides the energy necessary for lasing.

Neutron
An electrically neutral particle in the atomic nucleus. Neutrons and protons make up the nuclei of atoms.

Oscillator
A device that generates coherent optical energy. Generally, it consists of a laser medium placed between two mirrors. The optical energy bounces back and forth from mirror to mirror and intensifies. The Nova laser system's Master Oscillator creates the first laser pulse. At the optimum moment, the pulse is switched from the Master Oscillator and sent through the laser amplifier chain.

Photon

An elementary particle of light.

Pockels Cell

A very fast optical shutter that opens and closes in one-billionth of a second.

Proton

One of the elementary particles in the nucleus of an atom, it carries a positive charge.

Solid State Laser

This laser uses a solid, transparent substance, such as crystal or glass, as the means of amplifying the laser light.

Spatial Filter

A device used to enlarge and smooth the shape of the laser beam. It uses the telescope principle, but works in the opposite direction. It takes a large light pulse and focuses it down to a very small pinpoint of light then expands it out again.

Stimulated Emission

Radiation coherently emitted by excited laser ions when energized by a passing light wave which is tuned precisely to the laser wavelength.

Switchyard

This is the room in the Nova laser where the laser pulses are measured to insure they are acceptable and then they are switched into the target chamber room.

Target

Nova targets vary in size and shape. Often they are hollow spheres, each with a diameter that's half the width of a human hair. They are filled with deuterium and tritium, the fuel for the fusion reaction, and laser pulses are aimed at them, hence they are called targets.

Target Chamber

The Nova target chamber is a 16-foot diameter, hollow aluminum sphere. Powerful laser pulses are focused onto the target mounted in the center of this chamber and this is where the fusion reaction takes place.

Thermonuclear reaction

A nuclear-fusion reaction that takes place between the nuclei of a gas, especially hydrogen, heated to a temperature of several million degrees. Such conditions exist in the sun and stars, in a hydrogen bomb, and on a microscopic scale inside the Nova target chamber.

Tritium

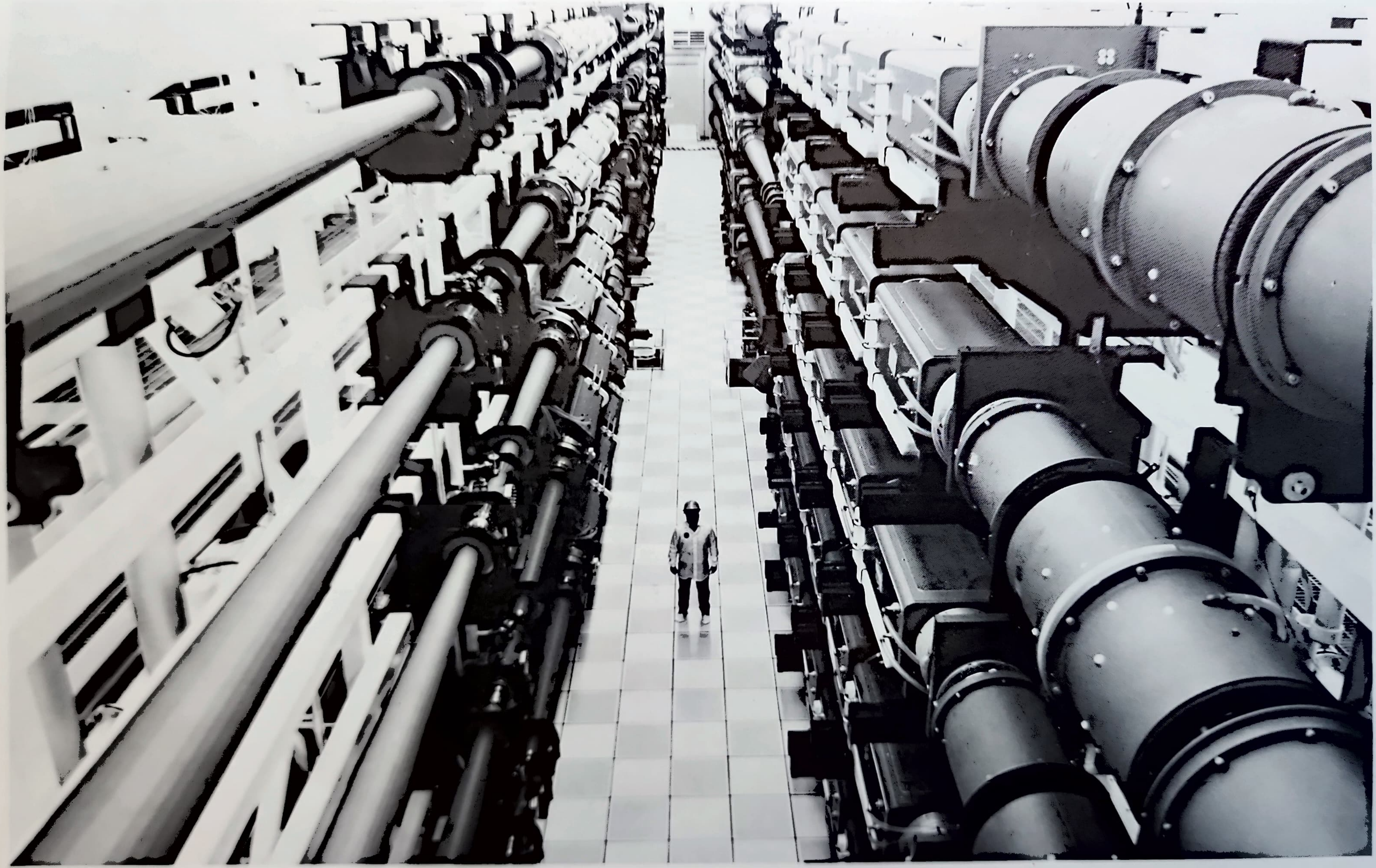
The isotope of hydrogen having one proton and two neutrons in its nucleus, tritium is made from lithium.

Uncollimated light

Uncollimated light spreads out in all directions like the light from a flashlight. Collimated light is light brought into line as in a laser beam or spotlight.

Wavelength

The length of a wave usually measured from crest to crest, wavelength defines the various forms of radiant energy that compose the electromagnetic spectrum and it determines the color of light. Light wavelengths used in the Nova laser are the one-micron infrared, the 1/2-micron green, and the 1/3-micron blue. Common units to measure wavelengths are the micron, the nanometer, and the angstrom.



The Nova laser system

U.S. Government Printing Office: 1987/9-785-002/68646

April 1985